



Armed Forces College of Medicine AFCM



Endocrine System

1- Pituitary Gland & Hypothalamus

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INTENDED LEARNING OBJECTIVES (ILO)



By the end of this lecture the student will be able to:

1. Describe the arrangement and mode of secretion of endocrine cells
2. Explain the structure of anterior pituitary gland
3. Relate the defective structure of the anterior pituitary gland cells to different clinical conditions
4. Explain the structure of Post pituitary gland
5. Relate the defective structure of the post pituitary

Lecture Plan



1. Part 1 (5 min) Introduction
2. Part 2 (35 min) Main lecture-pars distalis structure
3. Part 3 (5 min) Summary
4. Part 4 (5 min) structure of pars tuberalis and pars intermedia
5. Lecture Quiz (5 min)



- **Endocrine cells are either:**
 - **Grouped in specialized endocrine glands**, as pituitary gland, thyroid gland, parathyroid & adrenal gland.
 - **Individual endocrine cells in other specialized organs** as in heart, testes, ovaries, kidneys, liver & enteroendocrine cells.

Introduction



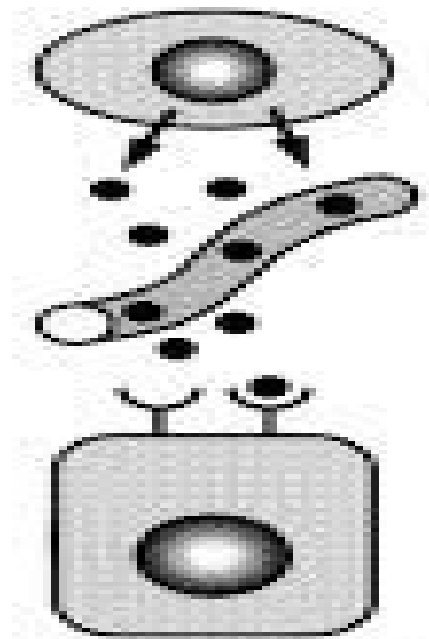
Endocrine glands are ductless glands, which secrete their secretions to □ extra cellular matrix in CT and blood capillaries.

Endocrine glands may be:

- 1) **Pure endocrine:** pituitary gland, thyroid gland, parathyroid gland, adrenal gland and pineal body.
- 2) **Mixed glands (both endocrine & exocrine):**
Testes, ovaries, liver, pancreas and kidney.
- 3) **Temporary endocrine glands:** placenta



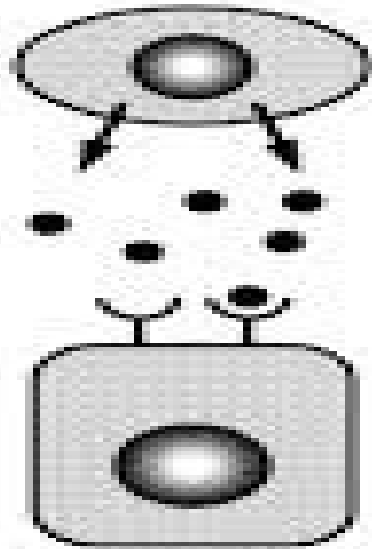
- **Types of endocrine secretion (cell signaling):**
- 1- **Endocrine:** endocrine cells → blood → distant organs.
- 2- **Paracrine:** endocrine cells → interstitial fluid or short loops of bl. Vessels → nearby cells.
- 3- **Juxtacrine:** secretion remains on the cell surface or adjacent extracellular matrix and affect target cell when contacting them.
- 4- **Autocrine:** cells secrete hormones that act on themselves or on cells of the same type.



endocrine



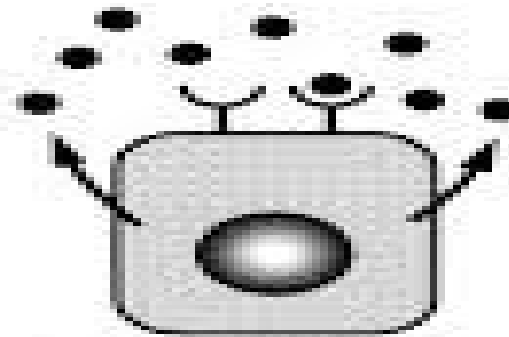
**Embryonic
and
regenerative
tissue
interactions**



paracrine



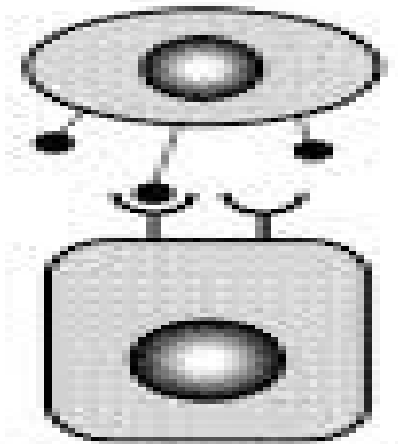
**IGF (insulin like
growth factor)
secreted by a
variety of cells
act on same cells
which produce
them**



autocrine



**Gastrin
secreted from
G cells in
pylorus affect
parietal cells in
fundus.**



juxtacrine

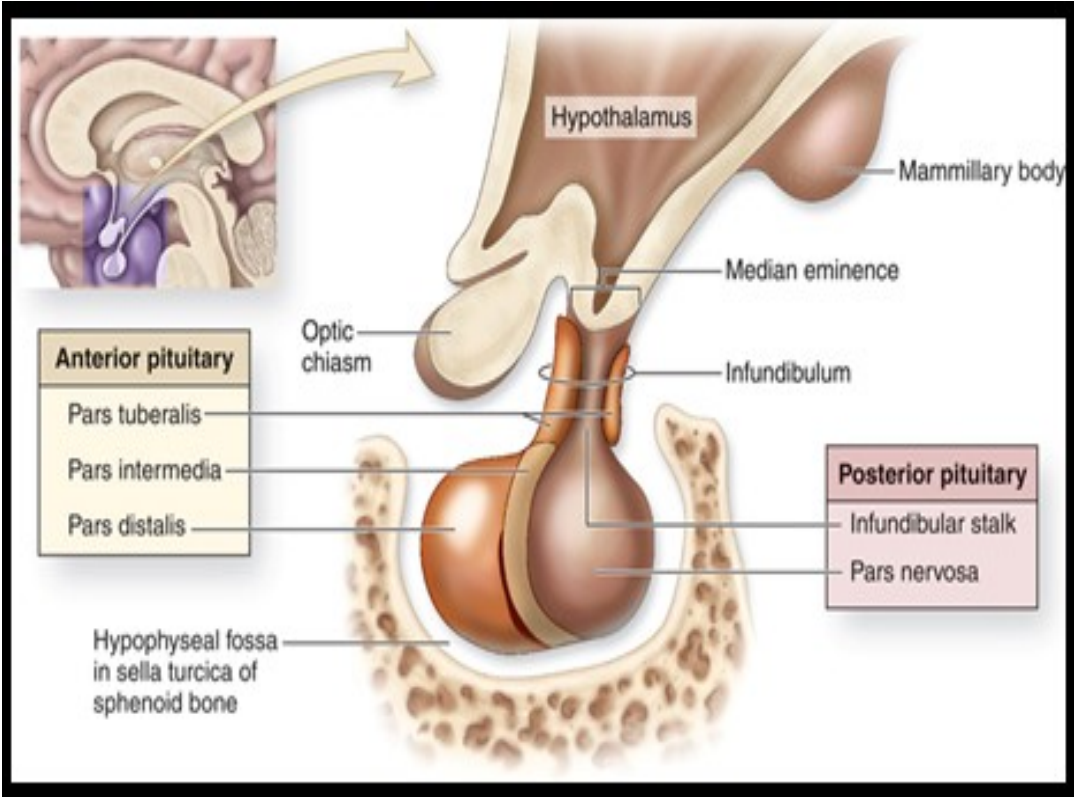


**TSH from
pituitary
(brain) act on
thyroid gland
(neck)**

Pituitary Gland (Hypophysis)



	Pars nervosa		Pars distalis
			Pars intermedia
	Infundibulum		Pars tuberalis





Structure of pars distalis

Anterior Lobe of Pituitary Gland (Adinohypophysis) I) Pars Distalis



Represent 75% of the total gland volume.

Formed of:

Stroma

Fibrous capsule &
Reticular CT

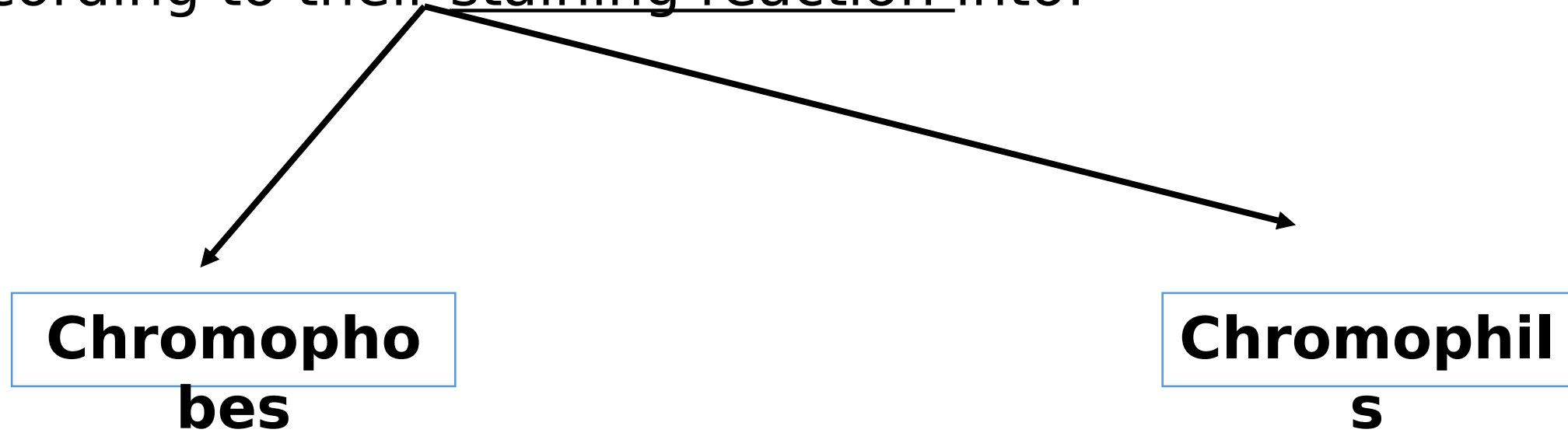
Parenchyma

Epithelial cells arranged in anastomosing cords & separated by fenestrated sinusoidal capillaries

Pars Distalis



Cells of the parenchyma of pars distalis are classified according to their staining reaction into:



Chromophobes

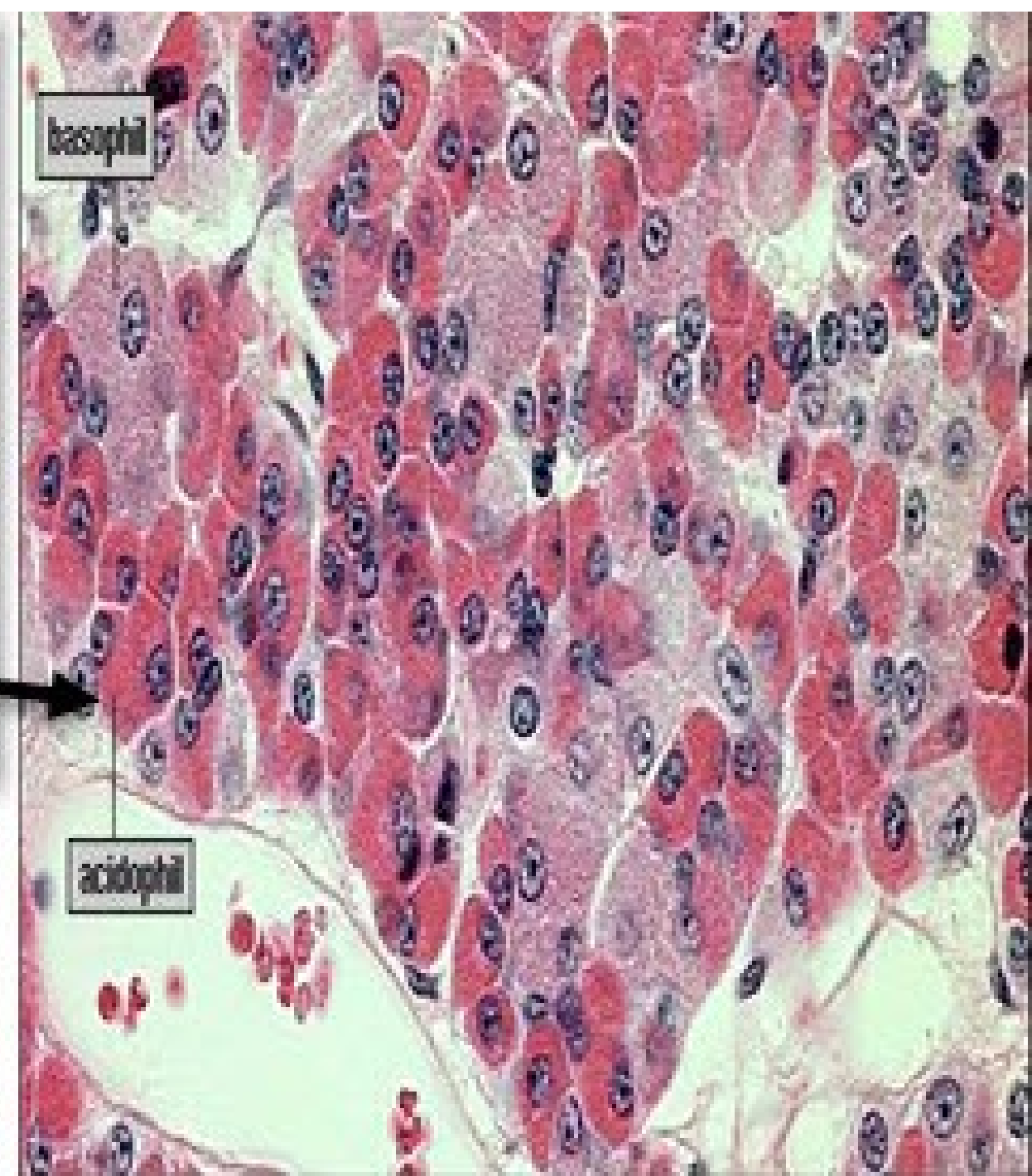
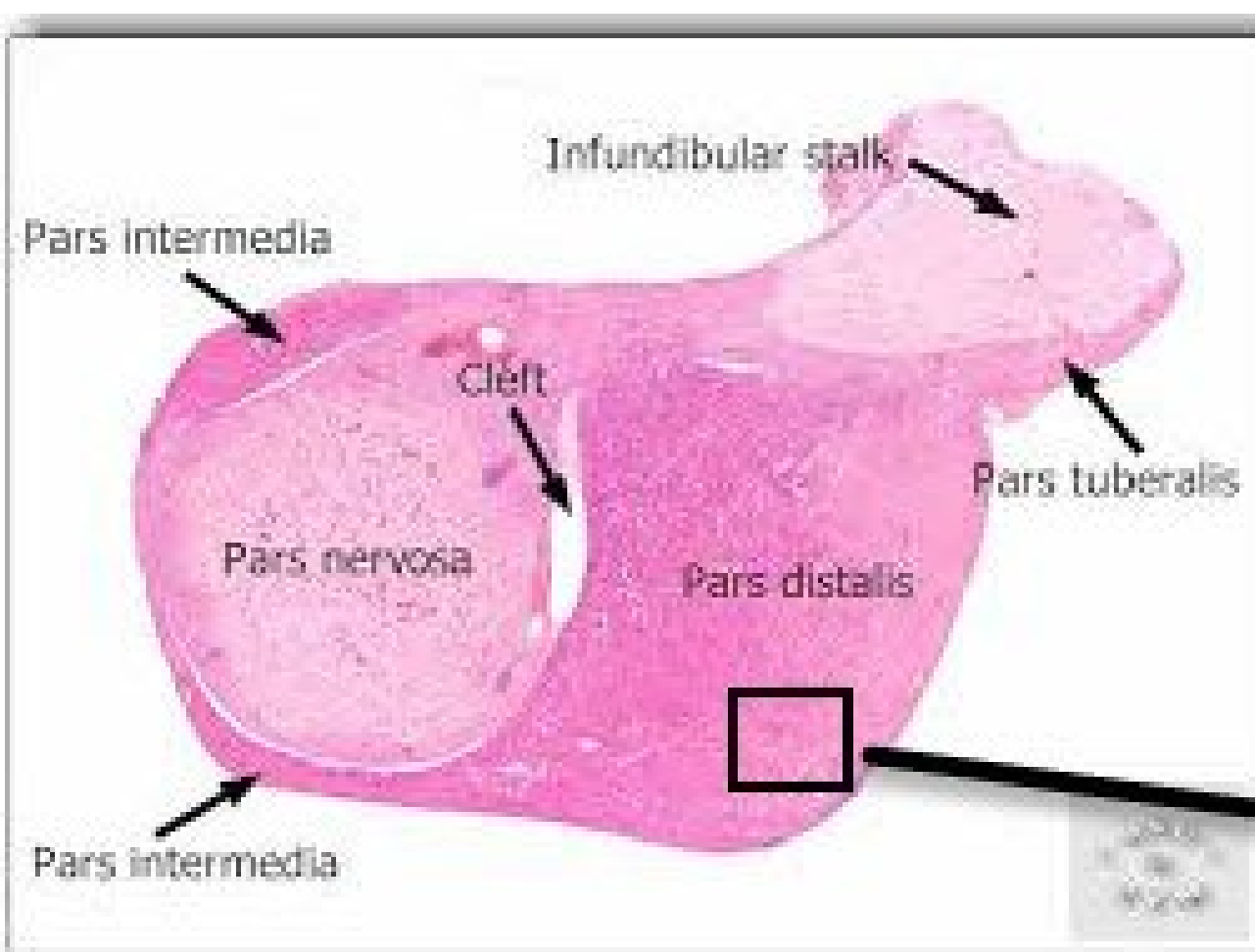


- 50% of cells in pars distalis.
- Have no affinity to stains.
- Smaller in size than chromophils.
- Polygonal cells with pale cytoplasm and central rounded nucleus.
- By EM , **few** granules appear in their cytoplasm.
- Chromophobes may represent:
 - **Degranulated chromophiles.**
 - **Undifferentiated stem cells.**
 - **Follicular stellate cells**, star shaped cells, with cytoplasmic processes encircling chromophiles & interconnected by gap junctions. Function in support and signal transmission from pars tuberalis to pars distalis

Chromophils



- 50% of cells in pars distalis.
- Have high affinity to stains.
- Subdivided into: (based on their affinity to **acidic** & **basic** dyes)
- (**Acidophils 35-40%**) & (**Basophils 10-15%**)
- They represent active hormone secreting cells.
- Their cytoplasm contain granules which can be differentiated by TEM or immuno-histochemical stains



Acidophils



Are further classified according to their histochemical staining into:

- 1- **Somatotrophs** □ secrete growth hormone
- 2- **Mamotrophs or Lactotrophs** □ secrete prolactin hormone

Both are considered ***non tropic hormones***, i.e: act on non endocrine target organs.

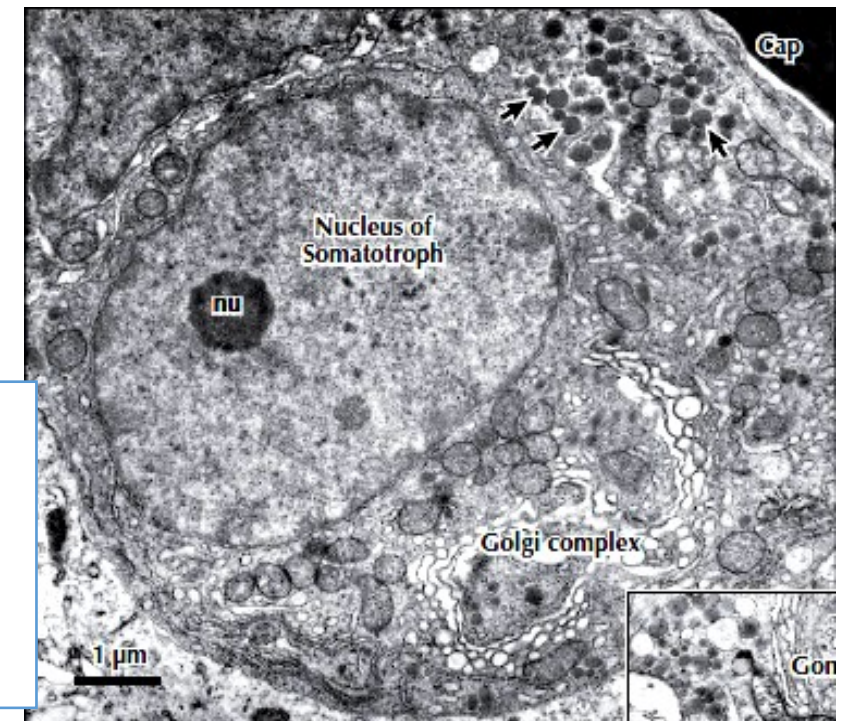
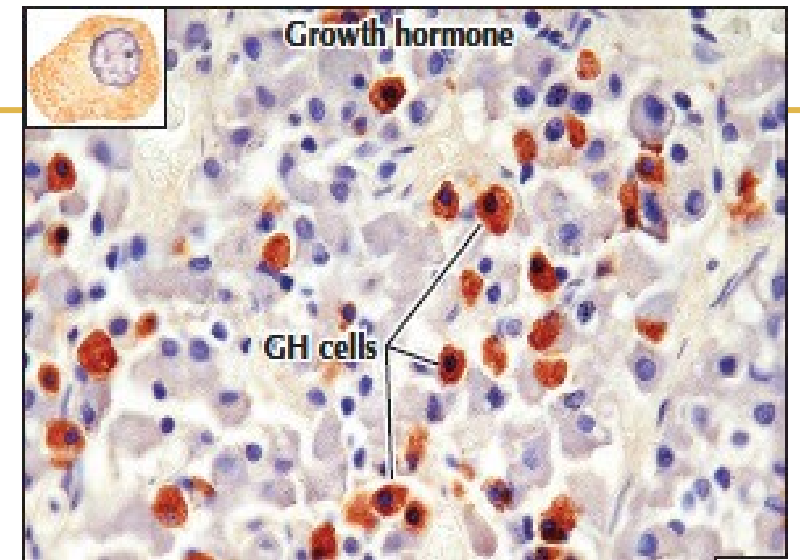
Somatotropes

Most numerous cells in pars distalis (50%).

LM: medium in size, oval in shape, have central rounded nucleus.

EM: closely packed dense secretory vesicles, 350 nm in diameter, well developed Golgi apparatus & rER.

Secrete **growth hormone** (somatotropin) □ stimulates growth in epiphyseal plates and in skeletal muscles, resulting in body growth.



Mamotropes (lactotropes)



- **LM**: Large polygonal cells- central oval nuclei.

EM:

- **D**uring lactation □ prominent golgi & rER. Secretory granules are sparse 200 nm.
- After lactation □ few rER & many lysosomes. Secretory granules are dense 600 nm
- During pregnancy & lactation, these cells undergo hypertrophy & hyperplasia increase gland size.
- Secrete **Prolactin** hormone □ development of mammary glands & initiates milk formation.

Basophils



- Are classified into 3 sub-types:

Corticotrops

Gonadotrops

Thyrotrops

Action

Adrenal gland cortex

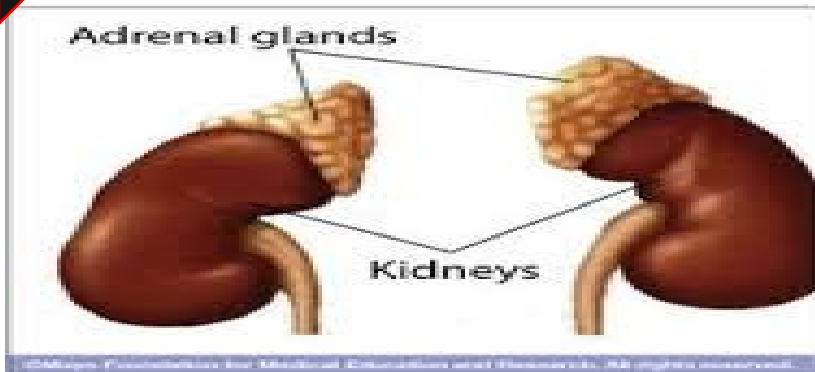
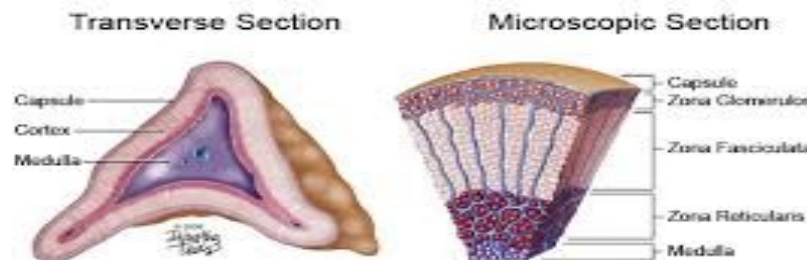


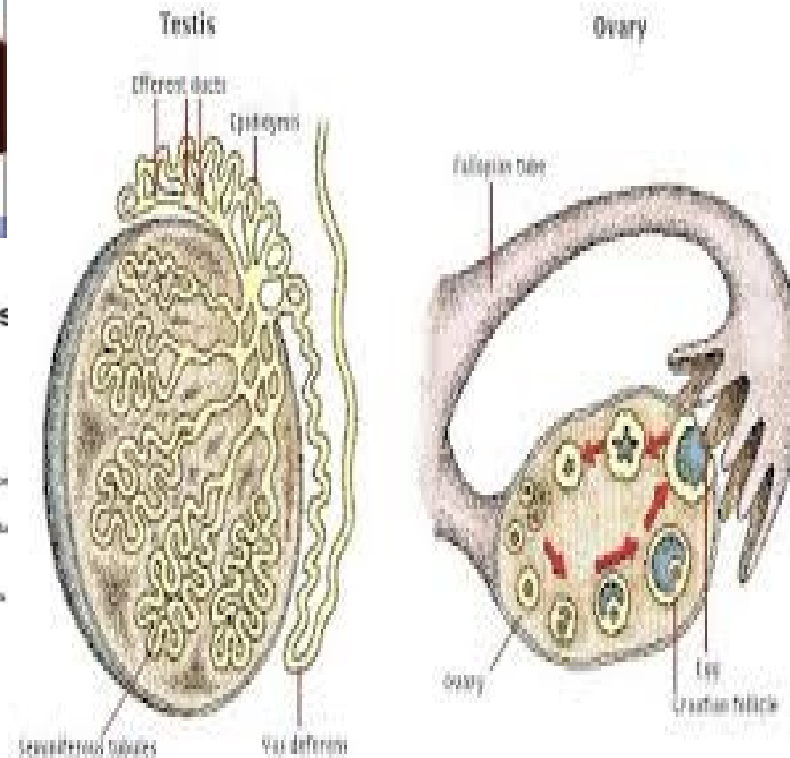
Figure 2: Adrenal Gland Cross Sections



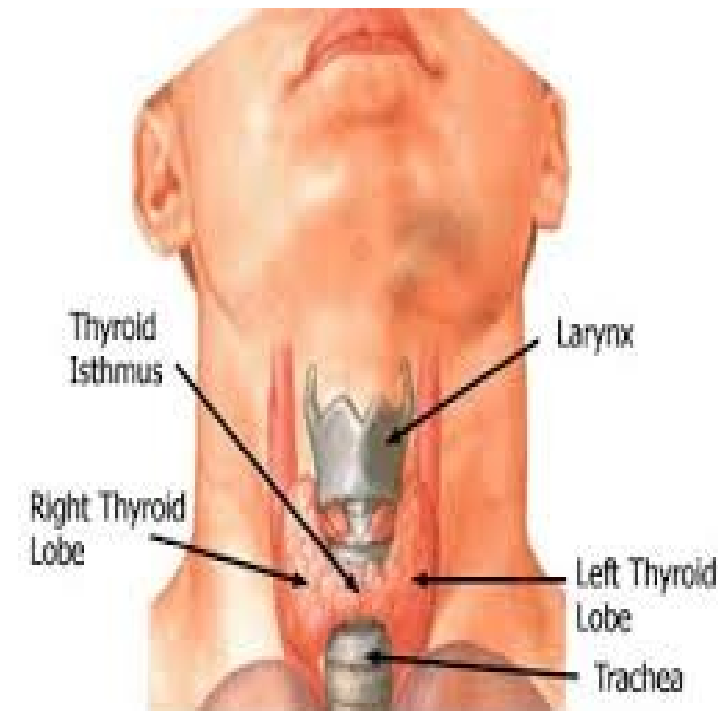
New Five Year Program

Gonads

- Ovaries in females
- Testis in males.



Thyroid gland



Corticotropes



LM: polygonal- medium sized – round eccentric nucleus.

EM: Contain golgi –rER – lipid droplets- lysosomes- intermediate filaments- secretory granules 100-300 nm.

Secrete pro-opio-melano-cortin(POMC) □ ACTH- melanocyte stimulating hormone (MSH)- β lipotropic hormone- endorphin & enkephalin.

Corticotropes stain as basophils and also exhibit a strong positive reaction with periodic acid-Schiff (PAS) reagent, because of the carbohydrate moieties associated with POMC

Corticotropes



ACTH, maintains structure and stimulates secretion of glucocorticoids and gonadocorticoids (adrenal androgens) by the zona fasciculata and zona reticularis of the adrenal cortex.

Secretion is stimulated by corticotropin -releasing hormone (CRH) from hypothalamus

Gonadotrophs



LM: Small oval cells- round eccentric nucleus.

Stains +ve with **PAS**

EM: prominent Golgi- distended rER- dense secretory granules 200-250 nm.

Secrete **2 hormones:**

A) Follicle stimulating hormone (FSH):

- In ♀: stimulate follicular development in ovaries.

- In ♂: stimulate spermatogenesis in testis.

B) Luteinizing hormone (LH):

- In ♀: Regulates final maturation of ovarian follicle, ovulation, and corpus luteum formation.

- In ♂: it is called **interstitial cell stimulating hormone (ICSH)** and is essential for androgen secretion by the Leydig (interstitial) cells of the testis.

Gonadotrophs

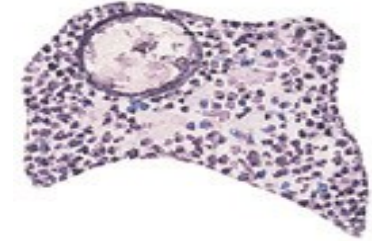


The release of FSH and LH is regulated by **gonadotropin-releasing hormone (GnRH)** produced by the hypothalamus.

Thyrotropes



Least cells in pars distalis.



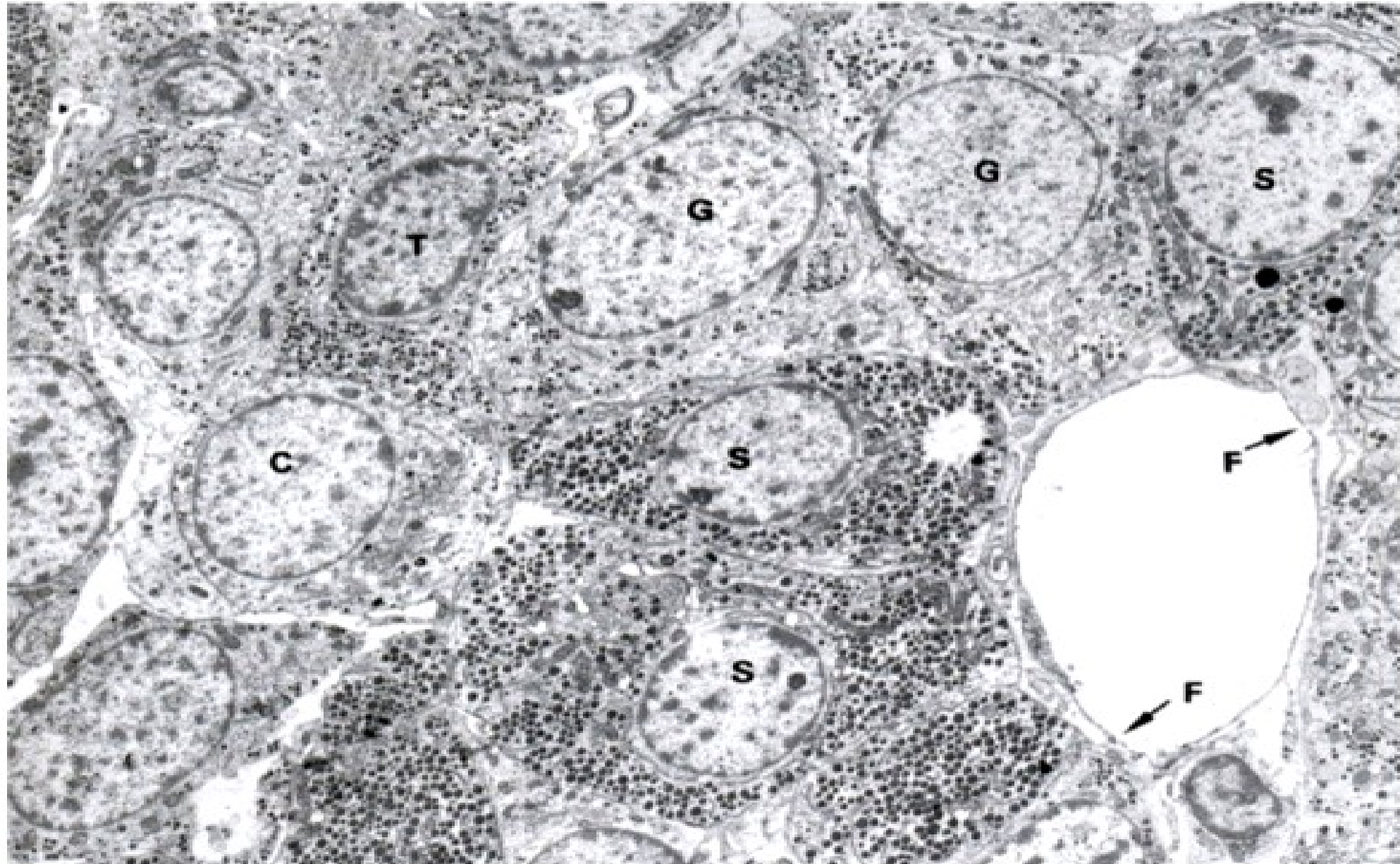
LM: large polygonal cells- rounded eccentric nucleus. +ve for **PAS**

EM: prominent Golgi – numerous dense secretory vesicles < 150 nm.

Secrete **thyroid stimulating hormone (TSH)**; □ follicular cells of the thyroid gland □ production of thyroglobulin and thyroid hormones.

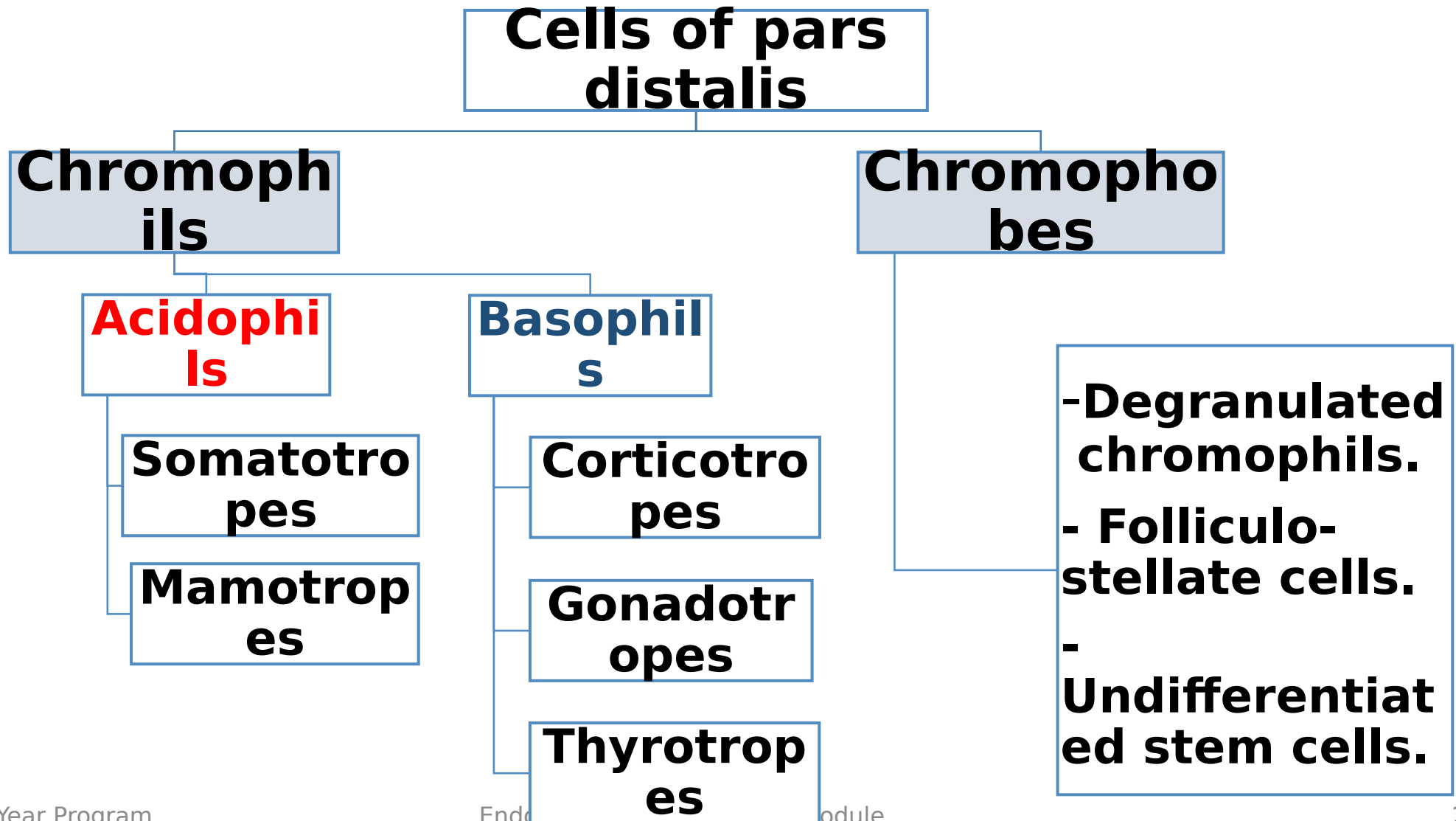
Release of TSH is under the hypothalamic control of

TEM of the Anterior Pituitary – note different granule morphology



C – corticotrophs (ACTH); G – gonadotrophs (FSH,LH) S – somatotrophs (growth hormone); T Thyrotrophs (TSH) ; F – fenestrated capillary

Summary



Comparison between acidophils & basophils



<u>Basophils</u>			<u>Acidophils</u>		
<u>Thyrotrophs</u>	<u>Gonadotrophs</u>	<u>Corticotrophs</u>	<u>Mamotrophs</u>	<u>Somatotrophs</u>	
Polygonal cells-round eccentric nucleus	Oval cells-eccentric rounded nucleus	polygonal-round eccentric nucleus	Large polygonal cells-central oval nucleus	Oval cell - central rounded nucleus	LM
Golgi-dense secretory vesicles <150	Golgi-rER-granules 200-250nm	Golgi-rER-Lysosomes-granules ~250	Golgi-rER - granules in lactation	Golgi- rER-dense granules 350 nm	EM

Clinical correlations



Pituitary adenomas of the adenohypophysis□

acromegaly in adults and ***gigantism*** in children. It is due to overproduction of growth hormone.

Cushing disease—an excess of corticotropin (ACTH)—which leads to overproduction of cortisol by adrenal glands.

Clinical correlations



Sheehan syndrome (*postpartum hypopituitarism*) □ *ischemic necrosis* of the anterior pituitary caused by severe postpartum *hemorrhage* □ cessation of lactation (*agalactorrhea*) and menstrual periods (*amenorrhea*, *hypotension*, and *fatigue*). Treated by Lifetime *hormone replacement therapy* (e.g., *estrogen*, *corticosteroids*, *thyroid hormones*) usually improves prognosis.

Kallmann syndrome

An X-linked inherited form that is also associated with loss of smell (*anosmia*). Failure of GnRH secreting neurons to migrate during embryogenesis from the olfactory placode to the forebrain and hypothalamus.

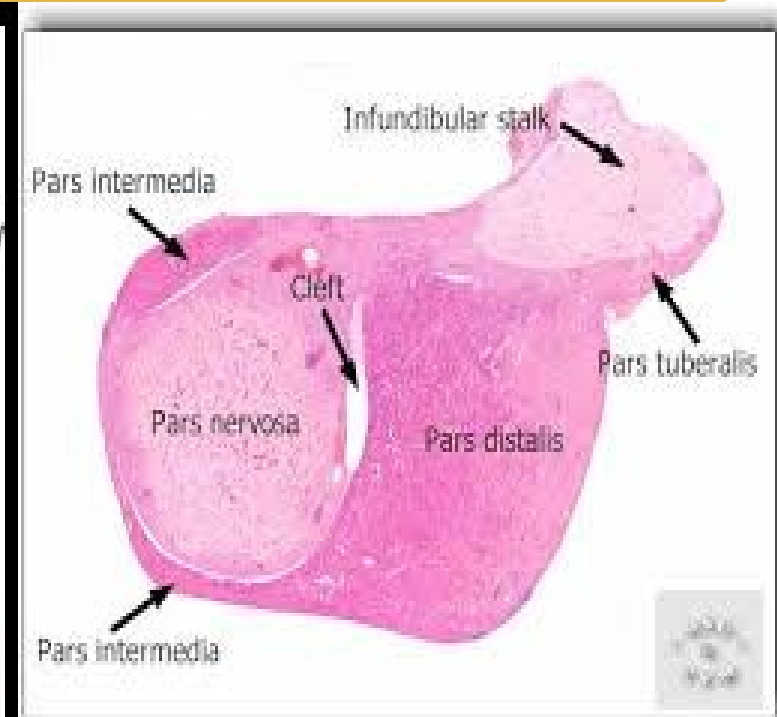
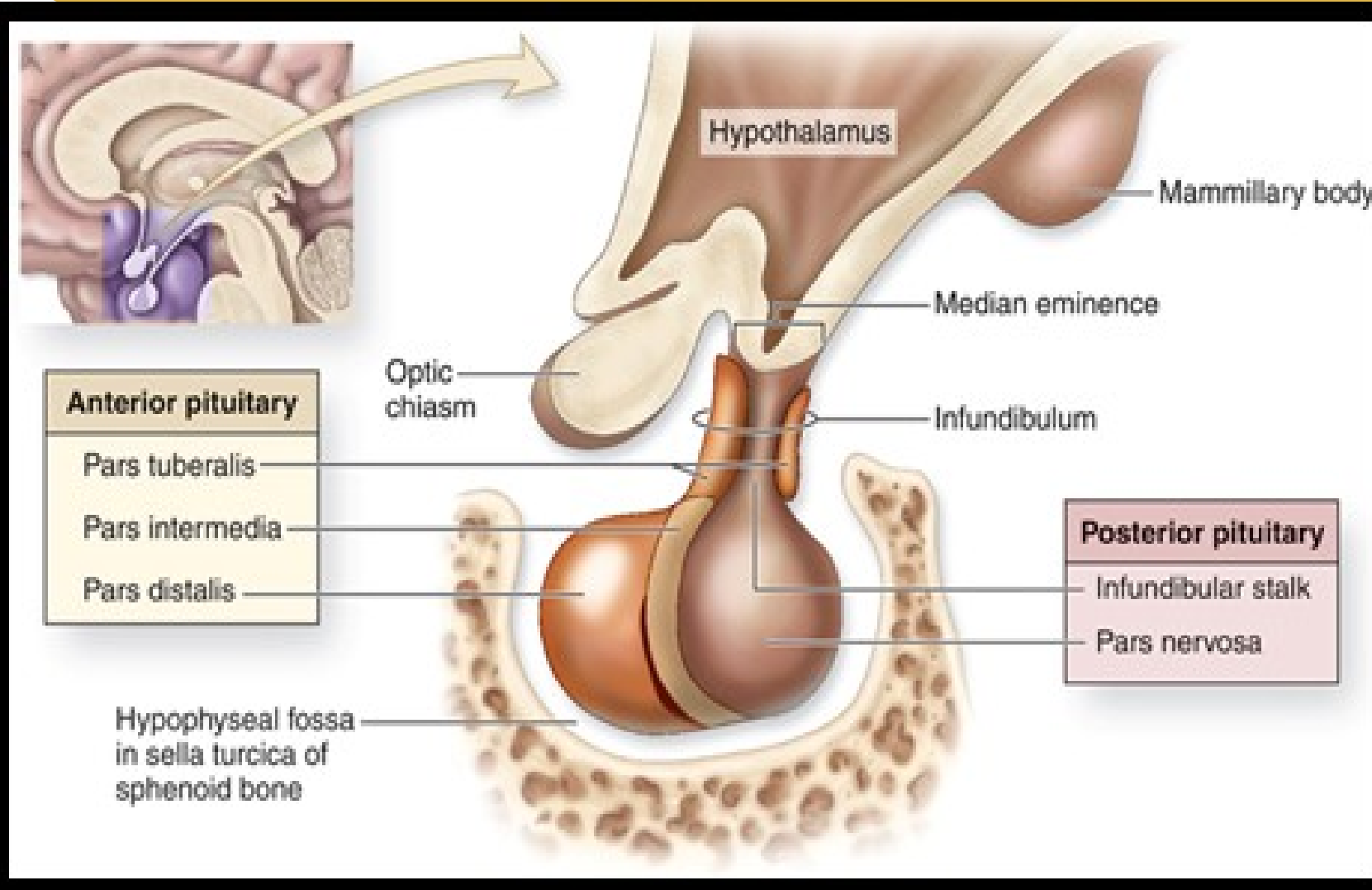
Main point-2



Structure of other parts of anterior pituitary

Anterior pituitary

Pars Tuberalis



- It is a smaller funnel shaped region surrounding the infundibulum of neurohypophysis

Pars tuberalis



The parenchymal cells are arranged in small clusters or cords in association with the blood vessels

Scattered nests of **sq. cells** and **follicles lined with cuboidal cells**

These cells often show immunoreactivity for **ACTH** , **FSH**, and **LH**

Anterior pituitary

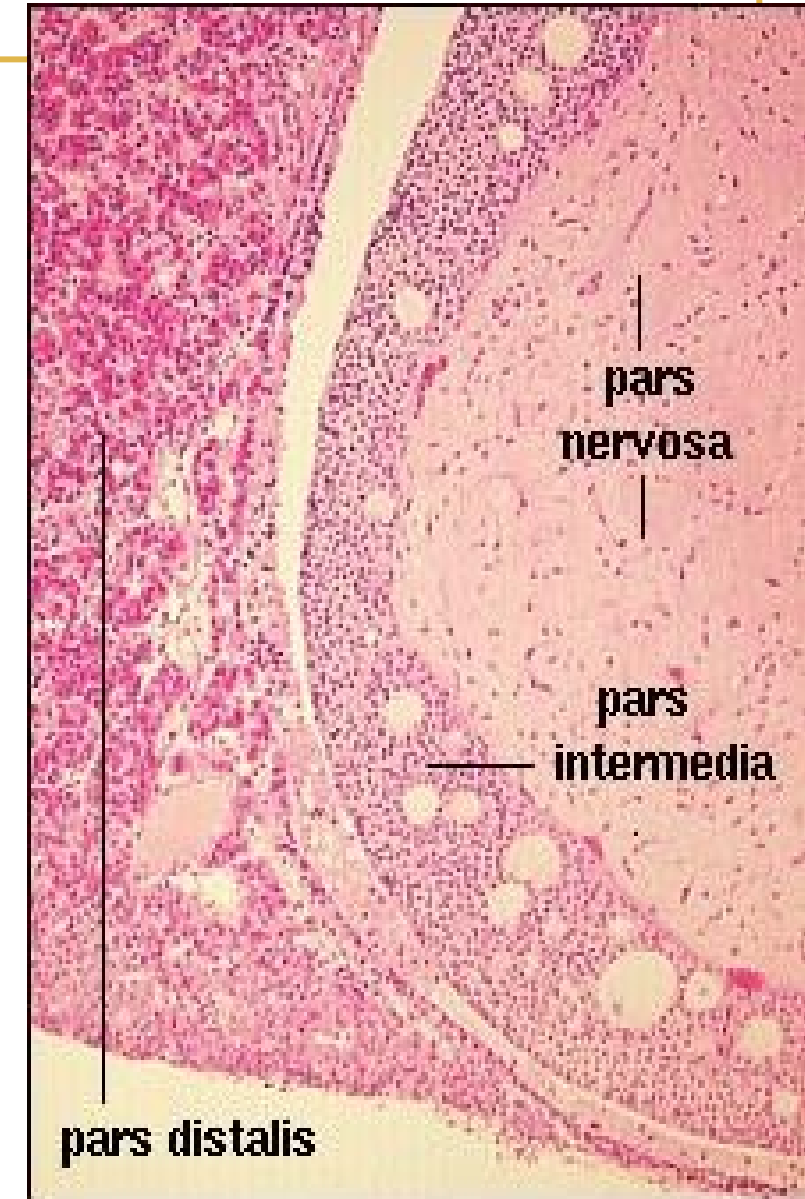
Pars intermedia



It is a thin zone of basophilic cells between pars distalis & pars nervosa.

Contain colloid filled **cysts**, **basophils** & **chromophobes**.

Cysts are lined by cells having junctional complexes and large vesicles. Cell origin is either folliculo-stellate cells or hormone secreting cells.



Pars intermedia



Basophils express MSH, γ LPH & α - β endorphin, so they were thought to be **corticotropes**.

Main point-3



Posterior pituitary

Posterior pituitary (Neurohypophysis)



Formed of:

Pars Nervosa

Contains:

- 1- Unmyelinated axons of hypothalamo-hypophysial tract & their terminals.
- 2- Herring (neurosecretory) bodies.
- 3- Pituicytes.
- 4- Fenestrated blood capillaries.

Infundibulum

**Connects
hypothalamus to
the pars
nervosa**

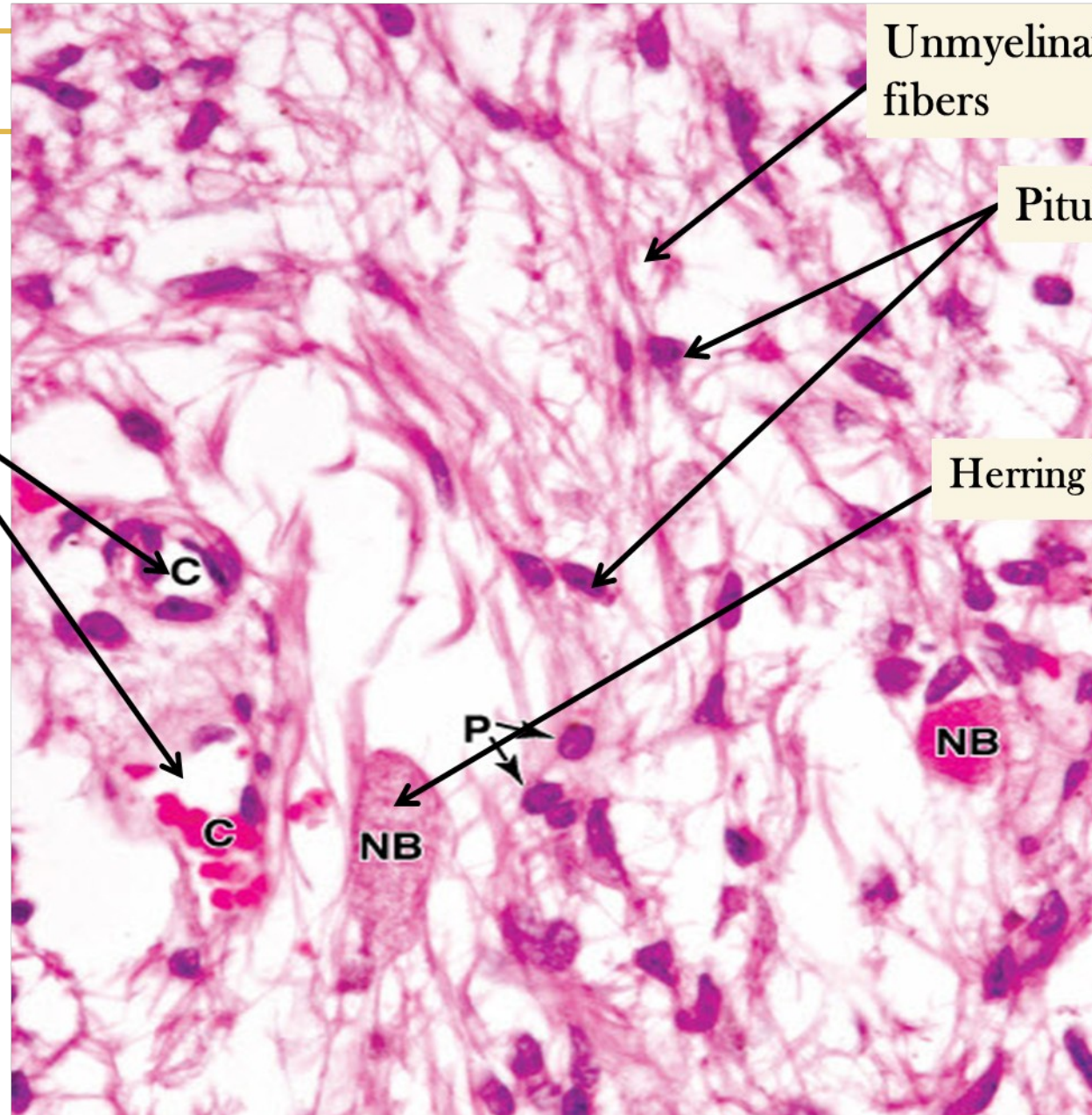


Fenestrated
capillaries

Unmyelinated nerve
fibers

Pituicytes

Herring Bodies





1- Unmyelinated nerve axons:

- Represent hypothalamo-hypophyseal tract.
 - Terminates close to fenestrated capillaries.
 - Convey neuro-secretory products of supraoptic & paraventricular nuclei of hypothalamus to pars nervosa.
-
- Their cytoplasm contains secretory vesicles and well-developed Nissl's granules.
 - Secretory vesicles form accumulations that dilate portions of the axon near the terminals called **Herring bodies**.

Unmyelinated nerve axons



- They differ from other fibers in:
 - A) Do not terminate on other neurons or target cells.
 - B) Secretory vesicles are present in all parts of the cell (i.e. cell body, axon, and axon terminal).
 - C) Larger in diameter.

The posterior lobe of the pituitary gland is not an endocrine gland, as it doesn't synthesize hormones, it is a **storage site for neurosecretions** of the neurons of the supraoptic and paraventricular nuclei of the hypothalamus.



2-Herring bodies:

- Are visible in light mic. as acidophilic bodies.
- Represent dilated portions of the axon which contains abundant secretory vesicles.



3- Pituicytes:

- Are the only cells in posterior Pituitary
- Associated with fenestrated capillaries.
- Branched cell with round or oval nucleus resemble astrocytes (**GFAP +ve**).
- **Function**: act as supporting cells.



Neurosecretory Vesicles

- Are membrane bound dense vesicles.
- Present in all parts of the nerve cell.
Contain secretions from supraoptic & paraventricular nuclei of hypothalamus.

-Contains:

- 1- Oxytocin.
- 2- Vasopressin (Anti-diuretic hormone).
- 3- Neurophysin (a protein that act as hormone carrier during axonal transport).
- 4- ATP.

Hormones stored in pars nervosa



	Oxytocin	Vasopressin (antidiuretic hormone)
Composition	9 amino acid peptide hormone	9 amino acid peptide hormone
Action	Smooth muscles of the uterus → contraction.	Distal tubules and collecting ducts of the kidney → increase water reabsorption → urine concentration.
	Myoepithelial cells of the secretory alveoli and alveolar ducts of the mammary gland → milk ejection.	Smooth muscles of blood vessels → vasoconstriction



Clinical Application:

Decrease or failure of action of Vasopressin □

Diabetes insipidus,

A disease characterized by polyuria (increase in the amount of urine) & severe thirst sensation .

Main point-4



Hypothalamus

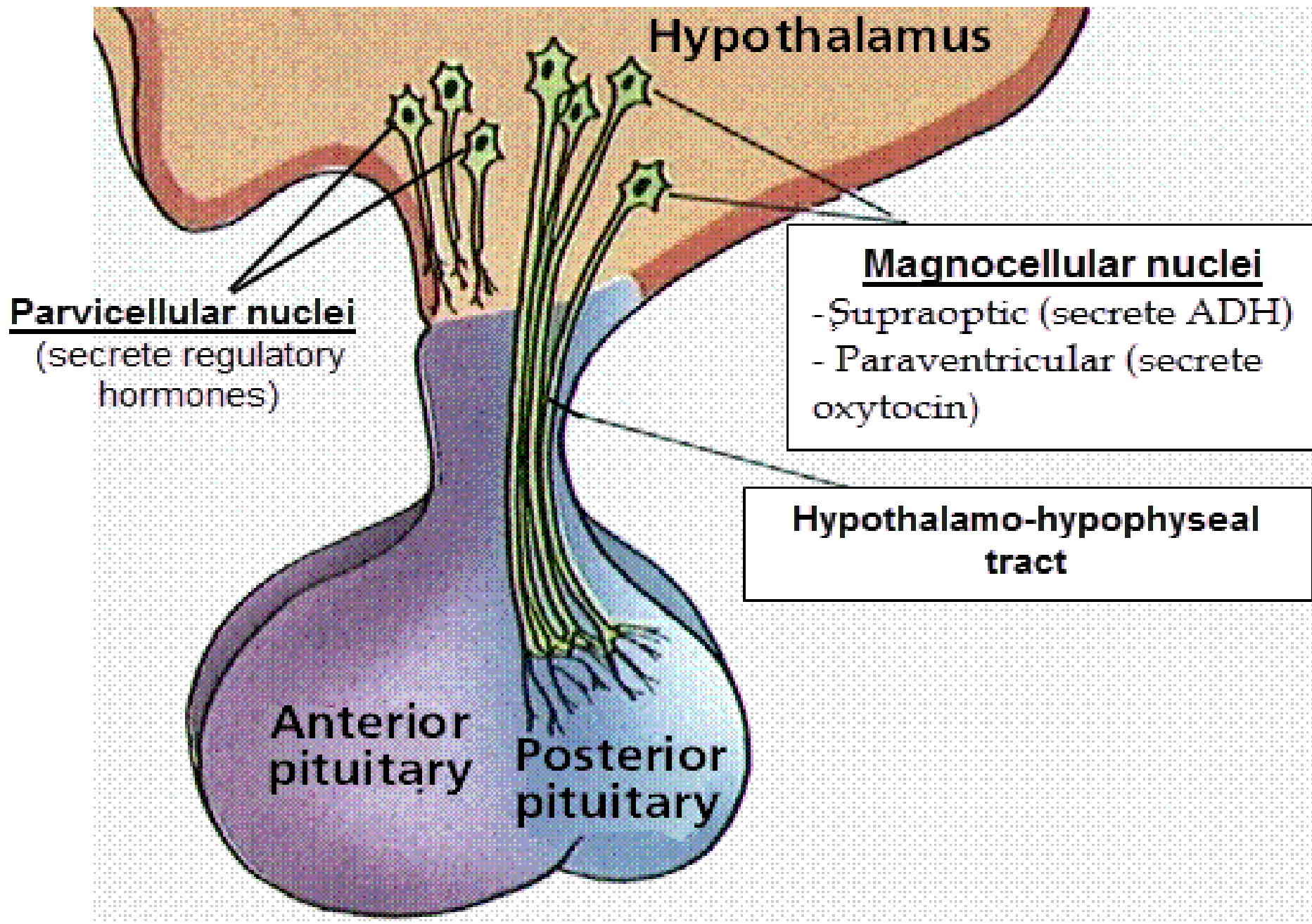
Hypothalamus



- It coordinates most endocrine functions of the body and serves as one of the major controlling centers of the autonomic nervous system
- Hypothalamus has many nuclei but those concerned with neuroendocrine system are 3, class **Parvicellular** **Magnocellular**

-Supra-optic &
Paraventricular nuclei
formed of large cells whose axons form the hypothalamo-hypophyseal tract.
- Secrete oxytocin and vasopressin.

- **Arcuate nucleus** formed of small cells which secrete releasing or inhibiting factors to 1st capillary plexus → ant. pit. Gland via hypothalamo-hypophyseal portal veins.



Lecture Quiz



Which of the following cells are one of the acidophils?

- a) Gonadotropes
- b) Mammotropes
- c) Thyrotropes
- d) Corticotropes

Which one of the following cells present in pars intermedia?

- e) Gonadotropes
- f) Mammotropes
- g) Thyrotropes
- h) Corticotropes

Lecture Quiz



Match the following hormones with their target sites:

- (1) ACTH
- (2) Prolactin
- (3) TSH
- (4) GH

- (i) Parafollicular cells
- (ii) Mammary glands
- (iii) Adrenal medulla
- (iv) Follicular cells
- (v) Epiphyseal plates
- (vi) Adrenal cortex

1 ☐ vi
2 ☐ ii
3 ☐ iv
4 ☐ v

Lecture Quiz



Which of the following cells are one of the magnocellular cells of hypothalamus?

- a) Arcuate
- b) Pitucyte
- c) Podocyte
- d) Tanicyte
- e) Supraoptic

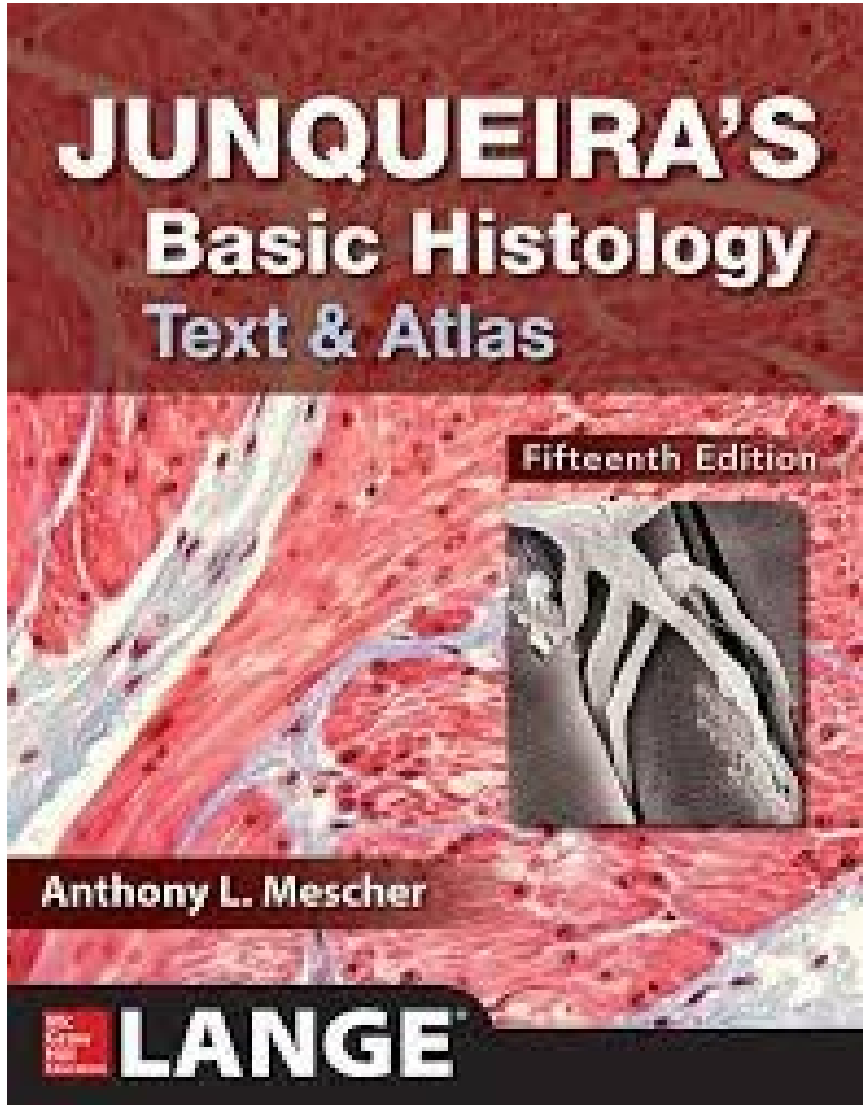
Lecture Quiz



Which one of the following cells present in pars nervosa?

- a) Arcuate
- b) Pitucyte
- c) Podocyte
- d) Tanicyte
- e) Supraoptic

SUGGESTED TEXTBOOKS



Chapter 20: Endocrine glands. Pp. 413-423